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RESEARCH SUMMARY

forest sciences

NELSON FOREST REGION

December 1996 RS-030

Shelterwood Harvesting in Root Disease Infected Stands - EP 1186 Preliminary Results - Ice Road Site

- **Pushover falling causes more damage to residuals and advance regeneration**
- **Root disease development and tree growth is being monitored for a number of years**

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INTRODUCTION

In the summer of 1993, the Nelson Region Forest Sciences section initiated a silvicultural systems trial to investigate partial cutting and root disease management. The trial is underway in two locations: Arrow Forest District and Golden Forest District. The Arrow site was harvested from January to March of 1996 and the Golden site was harvested the previous winter. This summary describes the harvesting operation, and provides preliminary post-harvest results for the Arrow site. For preliminary results from the Golden site, see Research Summary RS-023.

The specific objectives of this trial are to:

1. Demonstrate and compare the operational feasibility of harvesting small clearcuts and shelterwood cuts using conventional hand falling and mechanical pushover falling.
2. Evaluate the short- and long-term success of stump removal by pushover falling to ameliorate the effects of *Armillaria* (Arrow site) and Tomentosus (Golden site) root diseases, compared to no treatment (conventional hand falling).
3. Investigate the effects of these treatments on advance, post-harvest, and planted regeneration; vegetation development; root disease development; residual overstory growth; damage to residual overstory; coarse woody debris; soil disturbance; litter decomposition rates, and visual quality.

SITE DESCRIPTION

The Arrow Forest District study site is located on Ice Road, about 50 km south of Nakusp, B.C., in the Interior Cedar-Hemlock moist warm (ICHmw2) subzone. The timber type on the site is CwFdLw 633G7. Soils are predominantly silty loam and fine sandy loam. The site is north facing with slopes ranging from 25 to 35%.

Figure 1. Light shelterwood treatment

Pre-harvest root disease surveys indicated that *Armillaria ostoyae* is dispersed throughout the site. Also present are *Phellinus weirii* and larch dwarf mistletoe.

STUDY DESIGN

Eight treatments were established in a 2 x 4 factorial design with two replicates, for a total of 16 one-hectare (100 x 100 m) blocks. The first factor is harvesting method, and the second factor is level of basal area retention (figure 1).

Treatments:

1. Conventional clearcut
2. Conventional light shelterwood (13 m^2 residual basal area)
3. Conventional heavy shelterwood (25 m^2 residual basal area)
4. Control
5. Pushover clearcut
6. Pushover light shelterwood
7. Pushover heavy shelterwood
8. Control

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PRE-HARVEST ASSESSMENTS

Before harvesting, inventories of stand structure (Table 1), vegetation and woody debris were also completed.

Table 1. Pre-harvest stand characteristics

	species	m³/ha (no.)	m³/ha (cm)	Stems/ha	Avg. dbh
Layer 1 >12.5cm dbh	Cw,Lw,Fd	436	45	743	29
Layer 2 7.5 - 12.5cm dbh	Cw,Hw	–	–	200	–
Layer 3 1.3m ht. - 7.5cm dbh	Cw,Hw(Fd)	–	–	662	–
Layer 4 <1.3m ht.	Cw,Hw	–	–	1918	–

In all treatment units, a root disease assessment was completed before harvest. In addition, three 20 × 20 m plots were established in each of the clearcut and light shelterwood pushover units. These plots were examined for above- ground root disease indicators. When a post-harvest examination of stumps from these plots is completed, above-ground *Armillaria* signs can be correlated with below-ground incidence of the disease.

MARKING

All leave trees in the shelterwood blocks were marked before logging. Stands were marked to a specific residual basal area (either 13 or 21 m²/ha) to achieve a uniform distribution of acceptable stems, but favouring larger stems of Douglas-fir and larch. Markers used a combination of prism sweeps and target intertree distance to ensure they were approximating the target residual basal area. The species composition in the heavy shelterwoods was different than the light shelterwoods because as the residual basal area goes up, flexibility over what is marked goes down.

Table 2. Marked stand

	light shelterwood	Heavy shelterwood
m³/ha	131	209
m²/ha	13	21
Stems/ha (no.)	97	200
Avg. dbh (cm)	40	30
Species	Lw,Fd,Cw	Fd,Cw,Lw

HARVESTING

Three main skid trails were located during layout to provide access to all 16 blocks. These trails were built several months before harvesting to allow them to accumulate as much early-season snow as possible. This snow was packed down before harvesting to allow the trails to freeze.

Within each block, skidding was restricted to designated trails to reduce site disturbance and damage to advanced regeneration. Trail width and length were kept to a minimum and, where possible, snow trails were constructed to minimize other soil disturbance. Use of within-block trails was limited to small crawler tractors or the excavator. Skidders were allowed only on the three main skid trails to facilitate removal of wood.

Harvesting began the first week of January1996, and was completed by the second week of March. In general, over 50 cm of good, compressible snow was on site during harvesting.

Harvesting was completed by 3 two-person logging crews (1 pushover and 2 conventional). The pushover crew required approximately 40 days to harvest and skid 1800 m3 of wood. Accurate productivity figures for the two conventional crews are not available due to missed days, breakdowns, and periods with just one crew member working. A total of 2050 m³ was removed by the conventional crews.

PUSHOVER LOGGING

The pushover crew used a Linkbelt 2700 excavator for falling, and a small Caterpillar (D4) for skidding. The excavator was equipped with a bucket and thumb rather than a clamshell head. To improve the bucket and thumb head for pushover logging, the operator welded a large spool onto either side of the bucket (Figure 1). This allowed greater control of tree placement because the head could be used to both push trees backwards or pull them forward, thereby reducing damage to both residual and felled stems.

The operator was asked to buck the stump where the tree fell (rather than at the skid trail) and to leave the stump as close to the stump hole as possible. This avoided unnecessary machine travel for stump redistribution. The operator found the most efficient way to accomplish this was to fall five or six adjacent trees, shake them to dislodge any dirt and make sure no hinge roots remain in the soil, then shut down the machine and buck the stumps. Having one operator doing the falling and bucking worked quite efficiently and eliminated the potential safety hazards that exist if a separate bucker is used.

To ensure that the weight of the root mass did not cause the stump to shift after removing the counterbalancing weight of the bole, larger trees were bucked with longer stumps. Due to the longer stumps, utilization was likely lower than for the conventional units.

In one of the pushover heavy shelterwood blocks, trees were often quite large (50 cm dbh) and had a fairly clumpy distribution. A number of the marked leave trees were located within these clumps, often less than a metre from adjacent trees. Attempts to push over surrounding trees while leaving the single marked tree standing proved unsuccessful. While the leave trees did not actually fall over when adjacent trees were pushed over, there was substantial root disturbance and the marked trees

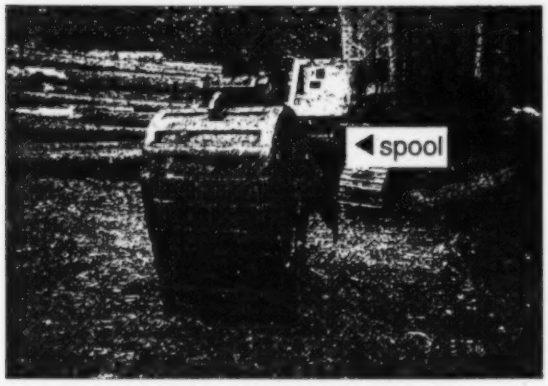

Figure 2. Bucket with spool attachment.

were often left leaning and unsafe. Examination of the exposed root systems showed that the root masses of adjacent trees were usually intertwined. The excavator operator found that for larger trees an intertree spacing of about two metres was required in order for one tree to be removed while retaining an adjacent one. The operator also found that cedar trees were more difficult to push over due to their large root masses.

The pushover operator also had problems manoeuvring in the heavy shelterwood blocks. The operator felt a 4 × 4m clearing was required to operate without damaging leave trees. He found the uniform distribution of marked leave trees often made it difficult to find an opening large enough to maneuvre within (both to avoid damage to leave trees, and to correctly position the crowns of pushed over trees into gaps between leave trees). A clumpier, less uniform distribution of leave trees would likely make the pushover operation much easier and reduce damage to residual stems.

A small proportion of the cedar stems developed very fine cracks under their bark, as a result of bending during the pushover phase before the root masses released. These cracks were not apparent on the outer surface of the bark and were not noticed until the logs were debarked at the mills. The cracks reduced the value of the logs from poles to sawlogs.

Informal assessments of stumps during the pushover operation showed generally good success in terms of both root removal and removal of soil from root masses. Pushover logging was found to be operationally feasible for use with both clearcut and shelterwood prescriptions; however, for shelterwood blocks consideration must be given to stand structure and species composition during the marking process to facilitate ease of operation. Specifically, if the stand is clumpy, it should be marked to leave or push over in clumps.

CONVENTIONAL OPERATION

One of the conventional hand falling logging crews also experienced problems in a heavy shelterwood block. The faller found that small cedar stems (less than 20cm dbh) with wide, full crowns often had insufficient weight at the top to allow the stems to fall through surrounding leave trees. This resulted in frequent hangups. In addition, these cedar stems were often quite short and did not reach the skid trails; the skidder operator had to pull extra line to remove the stems. Both these problems could be minimized by careful consideration of falling patterns and skid trail layout prior to logging. However, while reducing intertrail spacing allows easier skidding of these shorter stems, this could be a trade-off for incurring greater potential for site disturbance. Pulling extra line may be the better alternative.

PRELIMINARY RESULTS

Root Disease Assessment

Comparison of above-ground and below-ground signs of *Armillaria* infection confirmed the pre-harvest observation of a high incidence of *Armillaria* throughout, with no clearly delineated infection centres. In the pre-harvest above-ground survey, *Armillaria* was observed on 26% of Douglas-fir, 5% of larch, and 74% of red cedar. In contrast, below-ground assessment is showing *Armillaria* is present on a high proportion of the roots of larch and Douglas-fir that showed no above-ground signs. However, when *Armillaria* is present on cedar, it is almost always expressed above-ground (mycellial fans are commonly found under the flat side of the bole). Data collection continues, and a final analysis will be reported at a later date.

Soil Disturbance

A formal soil disturbance survey was completed in all blocks after harvesting (Table 3 and 4). Counted soil disturbance was generally higher in the pushover blocks. Disturbance levels varied little between treatments in the conventional blocks, but disturbance levels in the pushover blocks tended to increase with the increase in basal area removed.

Unplanned skid trails were built in two of the conventional blocks (light shelterwood and clearcut). Therefore disturbance levels could have been lower had the logging plan been followed. Higher-than-expected disturbance levels also occurred in the heavy shelterwood pushover blocks. One of the heavy shelterwood pushover blocks had clumpy tree distribution that made the pushover more difficult.

Table 3. Counted soil disturbance (%) by treatment.

	METHOD	
Treatment	**Conventional**	**Pushover**
Heavy shelterwood	2.9	7.4
Light shelterwood	5.4	8.3
Clearcut	3.0	19.7

Table 4. Average forest floor displacement (%) by treatment.

Treatment	METHOD	
	Conventional	Pushover
Heavy shelterwood	3.6	12
Light shelterwood	5.9	11.5
Clearcut	2.2	20.7

Under the Forest Practices Code, soil disturbance ratings guide silviculture prescription maximums for counted soil disturbance and forest floor displacement limits. According to the Soil Conservation Guidebook (Province of British Columbia 1995), these limits can be exceeded for pushover harvesting if approved in the prescription. The Nelson Forest Region Standard Operating Procedure (Ministry of Forests 1995) for soil conservation promotes main trail rehabilitation, therefore a post-rehab disturbance level of 15% is adequate at this time (M. Curran, Ministry of Forests, pers. comm., Nov. 1996). Therefore the clearcut treatment would not have complied without trail rehabilitation. Maximum allowable forest floor displacement would have been 30% under the FPC, and all treatments would have complied.

Damage To Overstory Residuals

Injuries to residual trees were counted and characterized in each of the treatment units. Similar levels of damage were found in the light and heavy shelterwood blocks, but the percentage of injured trees was much higher in the pushover blocks than in conventionally logged ones (41% compared to 13%). A higher proportion of cedar trees sustained injuries (36%) than Douglas-fir (18%) and larch (19%), probably due to cedar's thinner bark. Cedar injuries also tended to be larger. Most gouged the wood to a depth of more than 1 cm. Values for injury intensity were similar for cedar, larch, and Douglas-fir. The median injury size was 306 cm^2 (it is considered that injuries of 900 cm^2 or greater would result in significant decay).

Damage to Advance Regeneration

A key requirement in harvesting was the protection of advance regeneration wherever possible. Pre-harvest surveys indicated an average of more than 2500 stems/ha of Layers 3 and 4 regeneration (Table 1). Post- harvest surveys indicated that much less advance regeneration (16%) survived in the pushover blocks than in the conventional blocks (48%). Within the same falling treatment, a slightly higher proportion of regeneration survived harvesting in the shelterwoods than in the clearcut blocks. Similar results were found at the Golden site, suggesting that it is impractical to try to protect advance regeneration during pushover logging operations.

It is likely the designated skid trails helped protect more regeneration than if random skidding had been allowed, however high-use areas (i.e. adjacent to skid trails, etc.) still suffered greater losses than those towards the edges of each treatment unit. The small and square shape of the blocks may have been a greater contributing factor to damage than would be expected for a larger block.

Planting

All blocks, except the heavy shelterwoods, were planted in the spring of 1996 with Douglas-fir, larch, and cedar. The heavy shelterwoods were not planted because of higher residual stocking of all layers. Greater effort was required to find plantable spots on the pushover blocks because of slash buildup along skid trails. This is likely because of the large crowns present on much of the cedar component, and because much of the understory cedar component was destroyed during logging.

SUMMARY

Pushover falling in shelterwood and small patchcuts is operationally feasible. However, pushover falling caused more damage to residuals and advance regeneration than conventional falling. In addition, cracking reduced cedar log values, and long stumps caused minor volume losses. The long-term biological feasibility of the treatment, in terms of root disease development and tree growth, will be monitored for a number of years.

ONGOING RESEARCH

Research results from the various components of this trial will be published as they become available. All components of this project are funded by Forest Renewal BC.

REFERENCES

1. Forest Service. 1995. *Standard Operating Procedure (SOP) for soil conservation, timber harvesting, and mechanical site preparation*. B.C. Min. For., Nelson Forest Region, Nelson, B.C.

2. Province of British Columbia. 1995. *Soil Conservation Guidebook*. Forest Practices Code of British Columbia. B.C. Min For., BC Environ., Victoria, B.C.

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